UNIVERSITY OF SASKATCHEWAN

College of Engineering

G.E. 120.3

Introduction to Engineering II

FINAL EXAMINATION #1

March 1st, 2001

7:00 PM - 9:00 PM

STUDENT NAME: _____

STUDENT NUMBER: _____

LECTURE SECTION:

- L02 Tu-Th 11:30 – 1:00 Prof. T.G. Crowe
- L04 Tu-Th 1:00 – 2:30 Prof. H.C. Wood
- L06 Tu-Th 2:30 – 4:00 Prof. R.J. Bolton

Question 1	/ 10
Question 2	/ 15
Question 3	/ 15
Question 4	/ 15
Question 5	/ 15
Question 6	/ 15
Question 7	/ 15
TOTAL	/ 100

GENERAL INSTRUCTIONS FOR THE QUESTIONS

1) **NO** textbooks, **NO** notes, **NO** assignments, and **NO** laboratory logbooks/reports.
2) **NO calculators allowed**.
3) Neatness counts. Please ensure your paper is readable.
4) Some questions contain special instructions. Please ensure that you read these carefully.
5) Not all questions are of the same difficulty and value. Consider this when allocating time for the solution.
6) *IF A QUESTION PROVES TO BE TOO HARD FOR YOU TO SOLVE, GO ON TO ANOTHER QUESTION! RETURN TO THE TROUBLESOME QUESTION WHEN TIME PERMITS.*

PLEASE NOTE

ALL parts of the examination paper MUST be handed in before leaving.

Please check that your examination paper contains 8 pages TOTAL.

QUESTION #1

MARKS: 10 (2 + 2 + 2 + 2 + 2)

The general G.E. 120.3 Engineering Design Process involves 10 steps. You have used many (or all) of these in the G.E. 120.3 discipline specific design labs.

Discuss, briefly, any **five (5)** of the design steps.

For each of the design steps that you have discussed, give **one (1)** example of a specific activity that you undertook as part of a lab.

QUESTION #2

MARKS: 15 (5 + 5 + 3)

Answer each of the following questions. A short sentence or two should be sufficient. **Numerical answers are not required**.

a) In the Civil Engineering project laboratory it was noted that there were two methods under consideration for increasing the Factor of Safety (FoS). Briefly explain each method.

b) In the Mechanical Engineering project laboratory, what was your recommendation concerning double pane windows vs. single pane windows? Briefly explain how you reached your recommendation.

c) In the Chemical Engineering project laboratory it was noted that the malt/yeast mixture had to be diluted with additional water. Briefly expain the reason for this.

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QUESTION #3

MARKS: 15 (3 + 3 + 3 + 3 + 3)

Match each of the descriptions on the left with an item on the right (by drawing a line between them). Each item on the left can connect to one and only one item (maximum) on the right. Each item on the right can connect to one and only one (maximum) item on the left. Notice that there is one more item on the right than there is on the left. Therefore one of the items on the right will remain unmatched.

Use the most efficient means possible to determine the correct set of answers (see above for constraints). You do NOT have to justify your answers; just draw the lines.

The first one has been done for you.

a) A matrix that has a trace of 15.

b) A matrix that has a determinant equal to 9.

c) A matrix that has a determinant equal to 0.

d) An augmented matrix for a determinate set of linear simultaneous equations.

e) An augmented matrix for an indeterminate set of linear simultaneous equations.

f) A coefficient matrix, **A**, matrix after Gauss-Jordan Elimination has been performed.

1) $\begin{bmatrix} -1 & 4 \\ -3 & 3 \end{bmatrix}$

2) $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 2 & 4 \\ 3 & 2 & 5 \end{bmatrix}$

3) $\begin{pmatrix} 1 & 3 & 5 & 7 \\ 9 & 11 & 13 & 17 \\ 19 & 23 & 29 & 31 \end{pmatrix}$

4) $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 3 & 0 \\ 4 & 0 & 5 \end{bmatrix}$

5) $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$

6) $\begin{pmatrix} 1 & 3 & 5 & 7 & 37 \\ 9 & 11 & 13 & 17 & 41 \\ 19 & 23 & 29 & 31 & 43 \end{pmatrix}$

7) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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QUESTION #4

MARKS: 15 (5 + 5 + 5)

Evaluate the following expressions using the matrices **A, B**, **C** and **D** as defined below (show all work).

$$[A]=\begin{bmatrix}1 & 2\\ 3 & 4\end{bmatrix},\quad [B]=\begin{bmatrix}-5\\ 6\end{bmatrix},\quad [C]=\begin{bmatrix}7 & -8\end{bmatrix},\quad [D]=\begin{bmatrix}2 & 12\\ -4 & -3\end{bmatrix}$$

a) $([B][C])^T - [C]^T[B]^T$

b) $[A]-[B][C]$

c) $\left(\frac{[A][D]}{4}\right)^T$

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QUESTION #5

MARKS: 15 (15)

A garden supply center buys flower seed in bulk then mixes and packages the seeds for home garden use. The supply center provides 3 different mixes of flower seeds: "Wild Thing", "Mommy Dearest" and "Medicine Chest". One kilogram of Wild Thing seed mix includes 500 grams of wild flower seed, 250 grams of Echinacea seed and 250 grams of Chrysanthemum seed. Mommy Dearest mix is a product that is commonly purchased through the gift store and consists of 75% Chrysanthemum seed and 25% wild flower seed. The Medicine Chest mix has gained a lot of attention lately, with the interest in medicinal plants, and contains only Echinacea seed, but the mix must include some vermiculite (10% by weight of the total mixture) for ease of planting. In a single order, the store received 17 grams of wild flower seed, 15 grams of Echinacea seed and 21 grams of Chrysanthemum seed. Assume that the garden center has an ample supply of vermiculite on hand.

Use matrices and complete Gauss Elimination (to the point where the A matrix is upper triangular) to determine how much of each mix the store can prepare.

QUESTION #6

MARKS: 15 (15)

Use the determinant and adjoint method to compute the inverse of the following matrix. Verify your solution.

$$A = \begin{bmatrix} 2 & 1 & 2 \\ 3 & 2 & 2 \\ 1 & 2 & 3 \end{bmatrix}$$

QUESTION #7

MARKS: 15 (8 + 2 + 3 + 2)

The fuel ethane burns by combining with oxygen to form carbon dioxide and water as indicated by the following chemical equation:

$$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$$

Use matrix methods to balance the chemical equation for ethane combustion. Use the principle that there must be the same number of atoms of each element on each side of the chemical equation and that there must be an integer number of each molecule.

a) Develop the set of homogeneous simultaneous equations that can be used to determine the quantity of each molecule in the balanced equation.

b) What critical issue prevents you from solving this set of equations directly?

c) To solve this set of equations, assume (incorrectly!) that there is one water molecule (H_2O) produced, then rewrite the equations as a non-homogeneous set, in matrix form, that you could solve. Do not solve the equations here. (see part d)

d) Using Cramer's Rule, solve these equations for the number of each molecule, consistent with the principles and constraints outlined above.